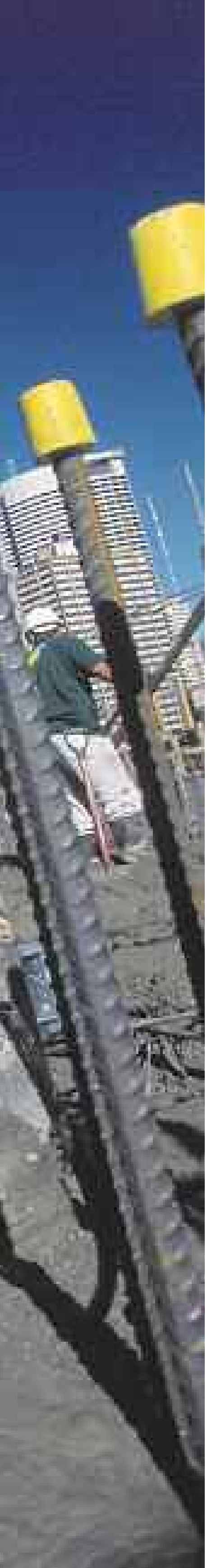
The Boral Book of Concrete



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STILLWELL
TRUCKS

Contents

Chapter 1 - What is Concrete?

What is Concrete?

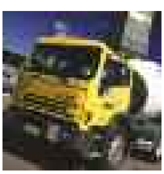
Cement and Concrete – Are they the same?

Many people think that cement and concrete are the same product - they are not. Cement is a dry powdered chemical that, when mixed with water, slowly reacts to form a new hard, solid compound. On the other hand, concrete is a mixture of cement blended with water and various sizes of aggregates. The cement and water form a paste that glues the aggregates together when it hardens. Concrete, in its freshly mixed state, is a plastic workable mixture that can be formed into almost any desirable shape. It starts to slowly stiffen when mixed, but remains plastic and workable for several hours. This is a long enough period to allow it to be placed and finished. After it takes its initial set, it continues to gain strength for months and sometimes years if moisture continues to be present.

What is Concrete?

Concrete has two components; aggregate and paste. Aggregates generally are of two sizes; fine and coarse. Fine aggregates are those with particle sizes smaller than about 5mm, commonly known as sand, which can be natural or manufactured. Coarse aggregates are those with particle sizes greater than about 5mm. Gravel, crushed stone and blastfurnace slag are among the most commonly used coarse aggregates. Paste is composed of cement, flyash, water and sometimes entrained air.

The cementing property of the paste results from a chemical reaction between the cement and water. This reaction is called hydration. It is a reaction that requires time and favourable conditions of temperature and moisture. “Curing” is the providing of favourable temperature and moisture conditions over a period of time long enough to allow the hydration process to approach completion. With proper curing, hydration takes place very rapidly at first, and then decreases slowly for a long time. This allows the concrete to develop good strength and durability. Remember, concrete needs continued moisture to harden properly. It should not dry out too quickly.



Strength of Concrete

The compressive strength of concrete, measured by how much force is required to crush it, is important in the design of structures. In pavements and other slabs on ground, the design is usually based on flexural strength, (ie; how much force the concrete can withstand in bending before it breaks). In either case, the principal factors affecting strength are the water-cement ratio and the extent to which hydration has progressed. The addition of too much water to concrete (beyond the intended mix design) will reduce strength and durability of the concrete, even if it is properly placed, finished and cured.

Properties of fresh Concrete

Although freshly mixed concrete remains plastic only a short time, its properties are important because they affect the quality and cost of the hardened concrete.

Concrete of plastic consistency (medium slump) does not crumble as it is discharged, but flows sluggishly without segregation of coarse aggregate from the finer material. Mixtures of such consistency are suitable for most work. The ease or difficulty of placing and consolidating concrete is called workability. Concrete should be workable; it should not be so stiff or so wet that segregation occurs; nor should it bleed excessively. Bleeding is the movement of water to the surface of freshly placed concrete. Excessive bleeding of water to the surface increases the water-cement ratio at the surface. A weak layer of poor durability may result, particularly if finishing operations take place while the excess water is present.

What do you order?

Concrete is bought and sold by the cubic metre volume of the freshly mixed ingredients. Specifications for concrete normally include a requirement for a certain design strength level for test cylinders cured 28 days, or they are based on a prescription of a specified cement content. Other characteristics such as slump and air content are also requested.

What makes good Concrete?

You do not need to be a concrete analyst. However, you should know that a certain quality is built into each mix design and you should be familiar with what constitutes good concrete:

1. Cement and water combine chemically to bond the sand and coarse aggregate together. Flyash may also be used as a cementing material, but always in combination with cement. The volume of water added to a certain volume of cement determines, to a large extent, how strong the hardened concrete will be. Most concretes are designed with a certain cement content and enough water to make the mass workable. Reducing the mixing water content makes the batch stronger and the addition of water makes the batch weaker.

2. Fine and coarse aggregate of a predetermined quality is added to the cement-water paste in the batch to give bulk to the batch. They contribute significantly to the quality of the concrete. If all fine aggregate (sand) is used to make a one cubic metre batch, a large amount of cement-water paste is needed to coat and bond the particles. By adding coarse aggregate to the batch instead of a portion of the sand, the mixing water demand can be kept lower. This works to produce better quality concrete at an economical cement content.

3. Admixtures - many of these are used (often in combination) to impart specific qualities to the fresh or hardened concrete. Some admixtures make the concrete set faster or slower, or make it denser, or make it stronger or more durable. The most common is an air-entraining agent which develops millions of tiny air bubbles in the concrete. These improve durability and workability. Water-reducing admixtures are also very common. They help produce a medium slump, workable concrete, with less required mixing water. Superplasticisers are a relatively new "breed" of admixture which can greatly increase slump with a relatively small dose. Once added to the concrete this slump increase will last up to 2 hours, with the concrete eventually returning to its original slump. Its main uses are -

   a) Flowing concrete (180mm plus slump) for ease of placement, labour savings and good off-form finish
   b) Medium slump concrete (100mm - 140mm slump) for exceptional pumpability (130 + metres high)
   c) Normal slump concretes (80mm) giving very low shrinkages due to reduced water content.

Chapter 2 - The testing of Concrete

The testing of Concrete

Technical Service to the Building and Construction Industries

Throughout Australia, Boral has established Concrete Testing Laboratories staffed by qualified and experienced personnel to assist with not only the quality control of our product but also to act in a technical advisory capacity to the building and construction industry.

Each of our laboratories is registered with the National Association of Testing Authorities Australia, and as such our certificates bear the endorsement - "This laboratory is accredited by the National Association of Testing Authorities Australia. The tests reported herein have been performed in accordance with the terms of accreditation."

This, in actual fact, represents a safeguard and protection for the concrete purchaser, the architect and/or the engineer and the owner, that the procedures used have been in strict accordance with the relevant Australian Standards.

Field Testing Service

As a further extension of these facilities a concrete testing service has been established. Upon request one of the company's field testing officers will go to the job site, measure the slump of the concrete, cast cylinders for either compressive or indirect tensile (Brazil Test) strength, cast beams for flexural strength, etc. On the following day they will return to the site to collect the specimens and transport them to the laboratory for standard curing, capping and crushing.

Concrete Research and Development Laboratory

Boral is also the only company to maintain a dedicated Concrete Research and Development facility. It was at this facility that special concrete mixes were developed for major projects such as Stadium Australia.

The Slump Test (AS 1012, Part 3) - Determining the consistency of Concrete

In many cases, the acceptance or rejection of a load of concrete depends upon a 15mm variation in the slump. This much variation can be, and often is, caused by poor slump test practices.

Sampling

If the slump test is to determine whether or not the concrete is to be accepted, the sample must be taken from the early part of the load. Never take the sample from the first concrete out of the mixer. Let out at least one fifth of a cubic metre before taking a test sample.

If the test is to be representative of the entire load, samples should be taken from three well-spaced parts of the load by passing the bucket through entire discharge stream of concrete and remixing them on a non-absorbent surface.

Right way to make a slump test

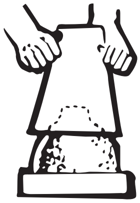
1. Moisten the inside of the cone and place it on a flat, level and firm surface - a piece of steel plate, concrete or stone slab, sheet or metal pan etc. This support should extend 50mm beyond the base of the cone to provide space for the concrete to spread when the cone is removed later. Hold the cone firmly in place when putting concrete in it by standing on the foot lugs.

2. Fill the cone with one-third of the volume (approx depth of 60mm) and rod the layer exactly 25 times with a round bullet-nosed steel rod of 15mm diameter, 600mm long. Rod uniformly over the entire concrete surface.

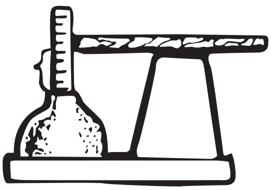
3. Fill the cone with the second layer until two-thirds full (approx depth of 150mm) and rod this layer 25 times uniformly over the entire concrete surface just penetrating into the underlying layer.

4. Fill the cone with the third layer until it slightly overflows and then rod this top layer 25 times uniformly over the entire concrete surface, just penetrating into the underlying layer.

5. Strike off the excess concrete from the top with a straight edge so that the cone is exactly filled. Remove spilled concrete from around the bottom of the cone.



6. Lift cone straight up slowly and gently approximately 3 seconds after filling, rodding and strike-off are completed. Never jar the concrete in any way until after the slump is measured in order to avoid possible incorrect results of the test.

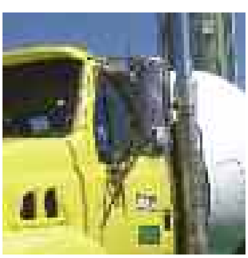


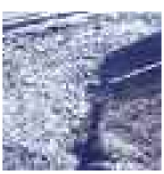
7. Measure the slump as shown in the diagram. If the top of the slump is irregular, do not measure the high point or the low point. Try to get the average. The slump shall be measured to the nearest 5mm for slumps 100mm and less, and to the nearest 10mm for slumps greater than 100mm.

Casting Compression Test Specimens
Moulds (AS 1012, Part 8)

The standard test specimen shall be a cylinder 100mm in diameter and 200mm long. These must "be of metal" with the ends "plane and perpendicular to the sides." The moulds must be fitted "with lugs or other suitable means for the attachment of base plates", the latter to be machined metal not less than 10mm thick.
The tolerance allowed on the machining of the base and cover plates is 0.05mm departure from the plane.

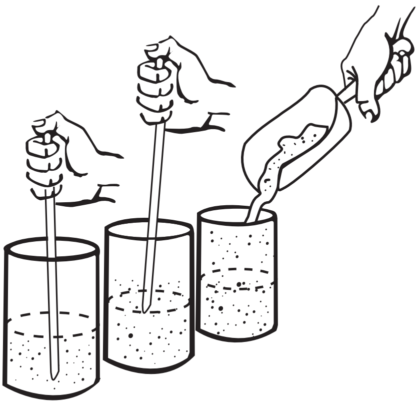
Before use, the inside surfaces of the mould and base plate should be thinly coated with a mineral oil to prevent adhesion of the concrete.





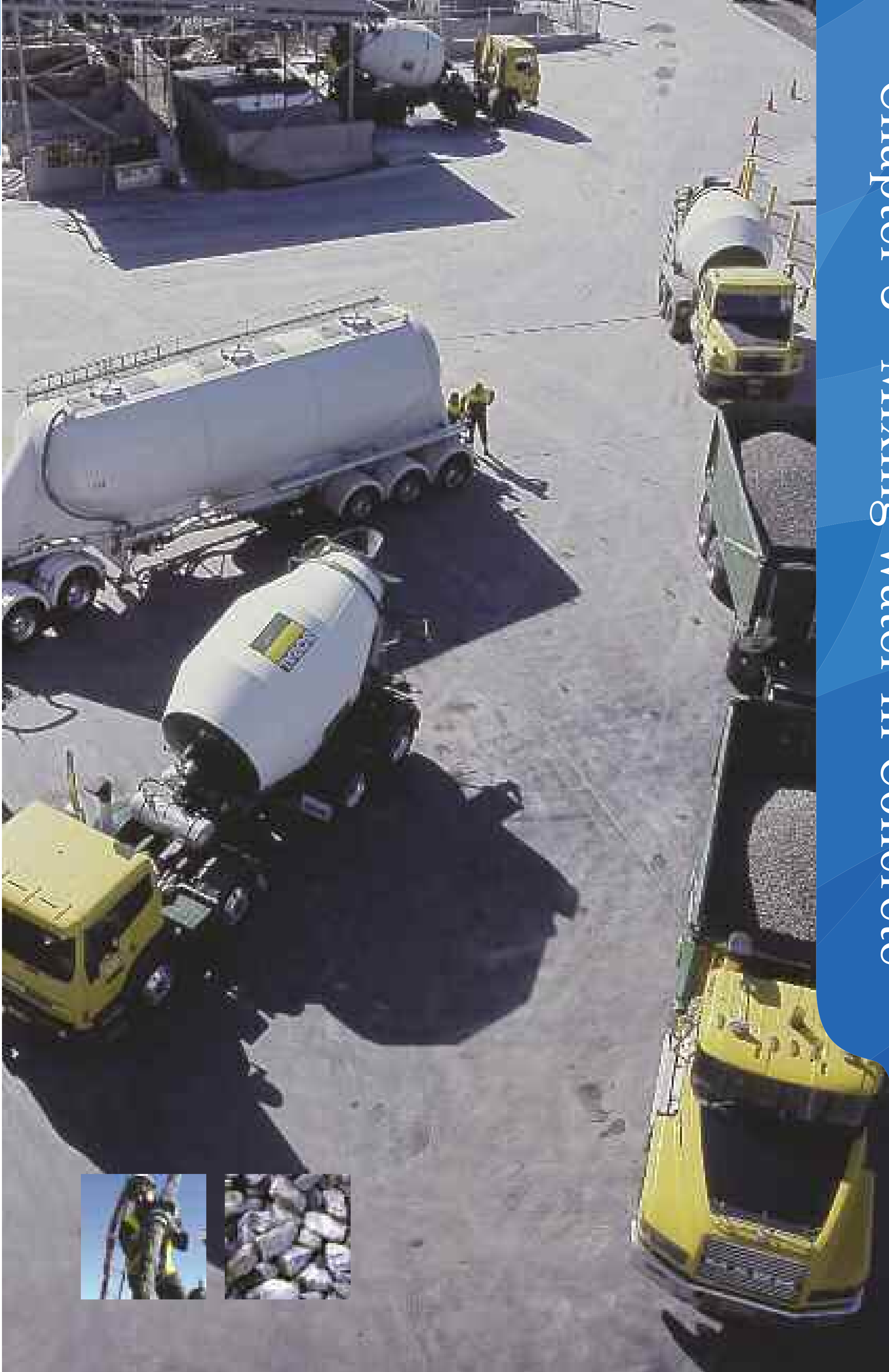
Filling and Compacting

The moulds are filled in "two approximately equal layers" and fully compacted usually by hand rodding for slumps of 40mm and above or by vibration for lower slumps down to 10mm.



i) By rodding - each layer shall be fully compacted using the standard tamping rod 15mm diameter, 600mm long, tapered for a distance of 25mm to a spherical shape end having a radius of approximately 5mm, the strokes being distributed uniformly over the cross-section of the mould. The bottom layer shall be rodden throughout its depth and for the upper layer, the first ten strokes shall just penetrate into the underlying layer. The number of strokes per layer shall be 25.

ii) Compaction by vibration - for standard cylinders two approx equal layers shall be used. All the concrete for each layer shall be placed in the mould before starting vibration of that layer. Vibration shall be continued only long enough to achieve full compaction of that layer. Over vibration shall be avoided.



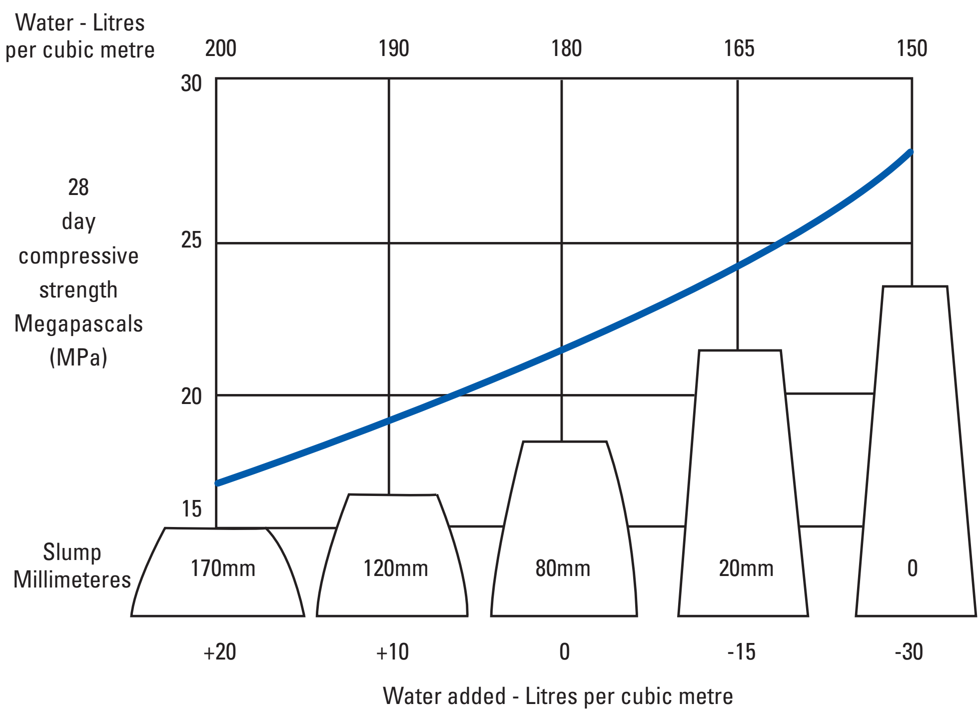
Chapter 3 - Mixing water in Concrete

Mixing water in Concrete

Perhaps no abuse of concrete is more common - or more costly - than the frequent use of too much mixing water. In a correctly proportioned concrete mix, only about half of the mixing water is needed to hydrate the cement. The remainder acts as a lubricant to produce workability. When more water than is actually needed for workability is added, the concrete is diluted, its density is reduced and it is weakened.

In terms of basic concrete technology, the compressive strength is proportional to the strength of the cement paste which is in turn dependent upon the amount of water present in the mix for a given quantity of cement, or the water-cement ratio. For the same quantity of cement, the more water used to produce a higher slump, the higher this ratio becomes and the lower is the resultant compressive strength. The effect on strength of increasing the slump on a truck load of concrete will be apparent from the graph below.

EFFECT OF WATER CONTENT ON STRENGTH AND SLUMP

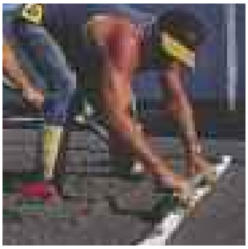


In addition to the loss in strength, other results of excessive mixing water include:-

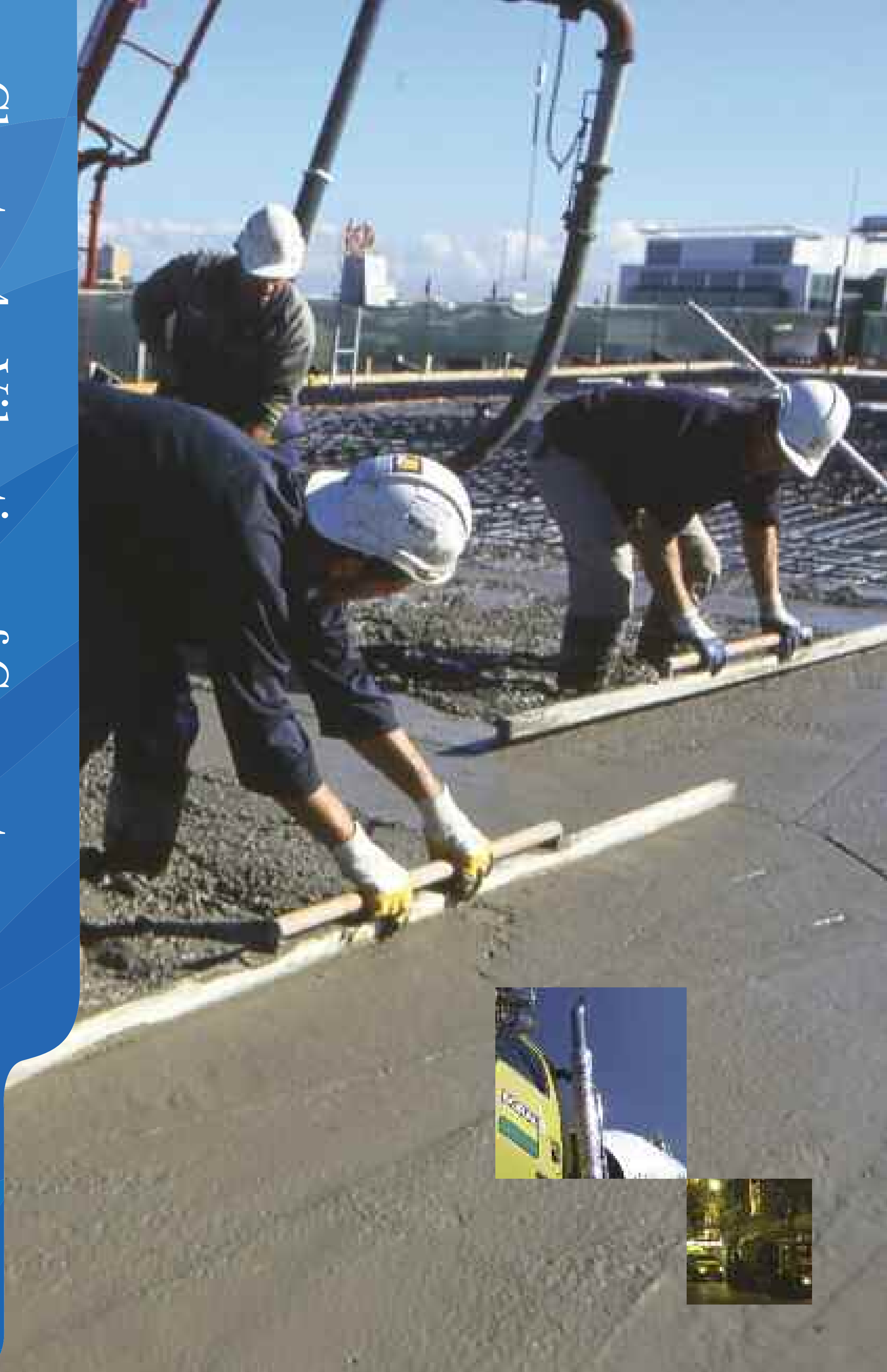
- Excessive cracking resulting from high shrinkage and low tensile strength caused by too much water.
- Dusting and crazing of slabs caused by excessive bleeding bringing fines to the surface.

Remember:-

- Stiff concrete is much less expensive when measured in man hours. It may require more labour initially to place, but it can be finished much sooner.
- Discharge concrete as soon as possible after it arrives on site. Prolonged mixing causes stiffening of concrete and may make it necessary to add water to maintain workability.
- Ensure that adequate manpower and equipment are available to place the concrete – place it rather than pour it.



Chapter 4 - Vibration of Concrete



Vibration of Concrete

Concrete for any structure must have a degree of workability - while in a plastic state – which will permit it to be moved into the final position where it will be allowed to harden.

Normally the plastic concrete flows around reinforcing in the forms, into corners and other areas. However, when the concrete is too heavily reinforced, with small clearances between the bards and forms, some mechanical aid is required to assist in the placing. Here vibration provides the best method for consolidation of the concrete.

Advantages of Consolidation by Vibration:-

- Efficient placement of stiffer concrete mixes which will give higher-strength, better quality concrete.
- Savings in time/costs through ease of placement.
- Greater density in the concrete.
- Greater homogeneity in the concrete - uniform consistency can be maintained throughout.
- Absence of voids, stone pockets and air traps.
- Improved bonds with reinforcement.
- More complete combination of successive layers.
- Reduces shrinkage in the setting concrete.

Low-Slump mixes

The higher strength and quality of concrete obtained by vibration result largely from the fact that a drier concrete can be placed.

Less free water, lower water-cement ratios, less volume change, all work for greater early and final strengths.

Vibration periods of 5 to 15 seconds are usually sufficient. The amount of vibration needed in one spot can be gauged by the surface movement and texture of the concrete, by the appearance of cement paste at the sides of forms, by the approach of the sound of the vibrator to a constant tone, and by the “feel” of immersion vibrators in the operators’ hands.

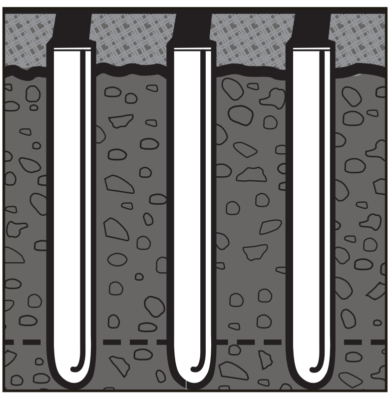
Overvibration

There is little likelihood of overvibration when the slump of the mix is as low as practicable.
When overvibration occurs, the surface appears very wet and in fact consists of a layer of mortar containing little aggregate. Generally, the slump, and not the amount of vibration, should be reduced. Overvibration of wetter mixes may result in horizontal stratification, with loss of durability.

Obviously, mixes of air-entrained concrete, or stiff mixes made with lightweight aggregates, should receive the minimum amount of vibration needed for consolidation.

Hand vibrators should not be used to transport concrete along a horizontal surface or to re-mix concrete in forms, as some segregation will occur.

Systematic vibration of each new layer is essential. The vibrator should be used at regular intervals of space and penetrate vertically approx 50mm into the previous layer which should still be plastic. Penetration at haphazard angles, spaces and depths does not result in a monolithic combination of the two layers.



Correct

Incorrect

Chapter 5 - Curing of Concrete

Curing of Concrete

Whether as a test specimen or in the job, concrete must be cured. The following notes give some background to this necessity.

What is hydration?

When cement is mixed with water it undergoes a chemical change that transforms it into "rock". When it hardens into a mass similar to rock, it is said to have hydrated. Therefore, hydration is nothing more than a chemical combination of cement and water. First, the outside of the cement particle hydrates and a cement gel (glue) is formed. As water continues to soak through this cement gel, further hydration takes place in the cement particle. This process goes on for many years just as long as moisture is present. The process of keeping the concrete damp and at about 21°C is known as curing.

Curing, why and how

Aggregate mixed with the cement becomes part of the "rock" mass. The process of transformation is most rapid during the first 28 days. Nothing can stop the transformation except a lack of water or subnormal temperatures. If concrete is allowed to dry out in the initial stages, it becomes permanently poor because water evaporated from the mix in the beginning cannot be forced back into the mix in time to prevent the cement gel from spoiling. Similarly, low curing temperatures can adversely affect concrete strength as shown in a comparison between job site cured and standard cured test cylinders. The job site curing was in a 200 litre drum with the temperature varying between 7°C and 9°C.

	Average Comp Str. at 28 days	
	MPa	%
27 days standard curing	22.7	100
6 days site curing then standard curing in lab	19.7	86.7
7 days site curing then standard curing in lab	17.7	77.8
13 days site curing then standard curing in lab	16.7	73.5
17 days site curing then standard curing in lab	15.6	68.6
19 days site curing then standard curing in lab	15.0	66.2
27 days site curing then standard curing in lab	14.2	62.6

Wearability

Since evaporation occurs more rapidly from the surface of concrete, the surface is affected by the length of curing time more than by any other single item. For instance, surfaces moist-cured for 28 days produce floors twice as hard as those protected only 3 days.

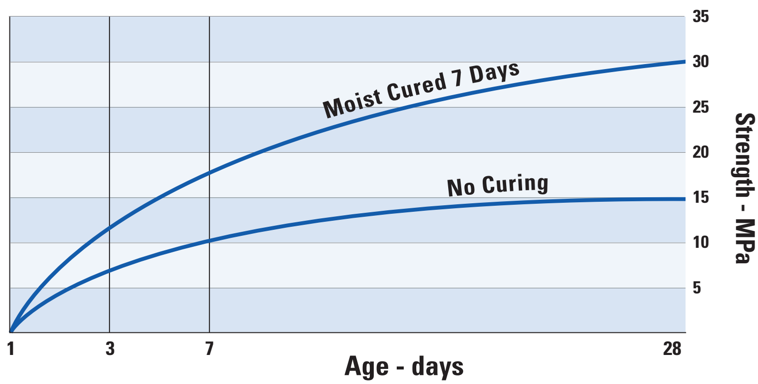
Watertightness

A well proportioned and workable concrete mix generally contains about twice as much mixing water as is necessary for hydration of the cement. The reason is that one half of the water is used to make the concrete workable. As the cement and water hydrates, a gel is formed and the gel expands to fill the voids which are left by the unneeded water as it evaporates from the concrete. You can readily see what happens if curing is stopped at one of the intermediate stages. The voids that are normally filled by the gel are left at whatever stage curing is stopped, making the concrete porous.

Curing of Concrete

Concrete curing techniques fall into two groups:-

- those designed to prevent loss of water, such as the application of impermeable membranes and
- those that supply moisture throughout the early stages of the hydration process, such as ponding or the application of wet sand or hessian.



Effects of curing

The longer concrete is moist cured the greater its strength.

If the concrete is to gain high percentages of its potential strength and durability it must have:

- Sufficient water for hydration of the cement.
- A temperature conducive to maintaining the chemical reaction at a rapid, continuous rate.

Methods of curing

We have given some of the reasons why it is necessary to cure concrete. Below are listed some of the methods to cure concrete. All the methods have advantages and disadvantages. The one used should be the one that will be the cheapest and most effective for the particular conditions under which the concrete is to be placed.

Methods	Advantage	Disadvantage
Sprinkling with water or covering with wet hessian.	Excellent results if constantly kept wet.	Likelihood of drying between sprinklings. Difficult on vertical walls.
Straw.	Insulator in winter.	Can dry out, blow away or burn.
Curing Compounds.	Easy to apply, inexpensive.	Sprayer needed – inadequate coverage allows drying out; film can be broken or tracked off before curing is completed; unless pigmented, can allow concrete to get too hot.
Moist Sand.	Cheap.	Can dry out, removal problem.
Waterproof Paper.	Excellent protection prevents drying out.	Cost can be excessive. Must be kept in rolls, storage and handling problem.
Plastic Film.	Absolutely watertight, excellent protection. Light and easy to handle.	Should be pigmented for head protection. Requires reasonable care and tears must be patched, must be weighed down to prevent blowing away.

Mechanical barriers absorptive covers

The use of waterproof building papers or plastic film (polyethylene sheeting) will also prevent the evaporation of moisture from concrete.

An absorptive medium such as sand, hessian or canvas will hold water on the concrete surface while curing progresses.

Plastic sheeting also has advantages of flexibility. It is easy to drape over complex shapes; and the progress of curing and conditioning of the concrete can be checked easily at any time.

To sum up the advantages of careful control of moisture concrete and temperature in curing

- The strength of concrete increases with age if curing conditions are favourable. Compressive strength of properly cured concrete is 80 to 100% greater than the strength of concrete which has not been cured at all.
- Properly cured concrete surfaces wear well.
- Drying shrinkage is greatly reduced and cracking is avoided.
- Greater watertighness of constructions is assured.

Points to keep in mind when curing

- Start the curing operation as soon as possible after finishing is complete.
- For proper curing concrete needs moisture.
- Continuity in curing is a must, alternations of wetting and drying promote the development of cracking.
- If during curing the concrete is allowed to dry out – as may happen in hot weather – the chemical change stops right at the point where the concrete loses its moisture.
- The ideal curing temperature is a constant 21°C.
- Cure concrete for at least 7 days.

Chapter 6 - Hot and cold weather Concreting

Hot and cold weather Concreting

Hot weather Concreting

The main things to consider during hot weather concreting are:

a) minimising the early loss of water from concrete;

b) preventing early setting through too-rapid drying.

If these problems are not anticipated, there may be:

- Strength reduction
- Shrinkage cracks
- Crazing or cracking
- Finishing difficulties.

In very hot conditions the following steps should be undertaken:

- Thoroughly moisten the sub-grade, reinforcing steel and wooden forms before placing the concrete.
- Avoid delay in placing the concrete. Have sufficient labour and equipment on hand to perform the placing quickly.
- During placement in very hot weather, try to shade the concrete from direct sunlight.
- Use wet coverings until final finishing can be completed.
- If a float finish is required, uncover only a small section immediately ahead of the finishers. Cover again at once after final finish.
- Keep covers wet.
- Start curing as soon as possible, using a method that will keep temperature of the covered concrete at or about a constant 21°C.
- Discharge concrete from waiting trucks as soon as possible. Heat builds up in mixer drums if this is not done.
- In very hot weather shade concrete from sunlight or use wet coverings until finishing can be completed.

Remember: Plan work in advance and have adequate labour available so that concrete can be handled rapidly.

Cold weather Concreting

Few areas in Australia experience temperatures low enough to warrant elaborate and expensive protection of freshly placed concrete. But frosts, abrupt drops in ambient temperature and/or prolonged periods of cold weather, are common in our winter seasons. Harmful effects of these conditions on new concrete can be avoided by relatively simple measures in ordering, placing and curing.

Placed concrete is a “gel” formation which hardens over a period of weeks. Generally, the lower the ambient (surrounding) temperature, the slower the rate of hardening.

At an ambient temperature just above 0ºC the development of strength in unprotected freshly placed concrete is very slow. If the ambient temperature drops to or below 0ºC some of the water in the concrete may freeze, setting will virtually stop until it thaws and this interruption of hydration increases porosity and reduces final strength and durability.

Because some heat is generated during the hydration process, ordinary concrete has a minor inherent resistance to the freezing of its water content after placing. But when the temperature of the concrete surface itself falls below freezing point, the water content near the surface will solidify in an almost instantaneous surge, increasing its volume by about 10% and causing tensile pressure as high as 210 MPa in concrete which is no longer plastic. Scaling or spalling will follow, and will become more severe if several freezing/thawing cycles occur.

The use of aggregate of high porosity in concrete can increase scaling/spalling problems.The aggregate particles near the surface will expand when frozen. Moreover, as most porous aggregates have poor abrasion resistance, the damage will be intensified by separation of particles from the cement paste.

Air entrained concrete mixes have excellent resistance to surface scaling or bursting after freezing because, as ice crystals begin to form, residual water under pressure moves into the millions of small air cells in the concrete, thus relieving stress. The addition of any air entrainer increases slump, the obvious answer will be to reduce the amount of water in the mix and thus derive an even greater benefit in terms of increased durability.

An interesting comparison can be provided between:

1. An ordinary concrete mixed and cured at 5ºC and
2. An identical concrete mixed and cured at 21ºC.

The 3 day strength of the first concrete (5ºC) could be expected to be only 30% of the 3 day strength of the second concrete. At 7 days the relative strength of the low temperature concrete might be 50% and at 28 days 80%.

Ordinary concrete mixed at 21ºC but placed in an ambient 5ºC will gain strength fairly rapidly if the surrounding temperature increases.

Chapter 7 - Cracks in Concrete

Cracks in Concrete

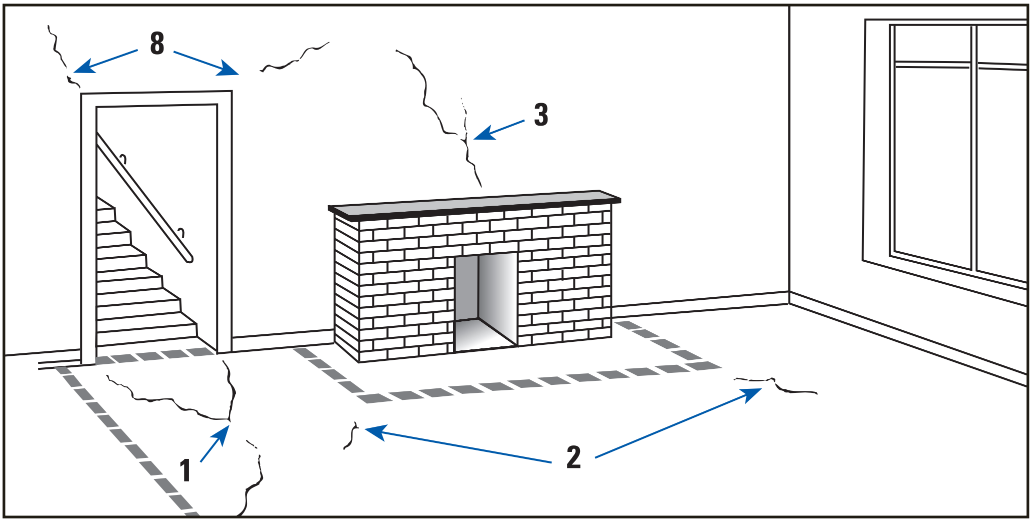
Concrete, when placed is a mass containing more water than is required for hydration of the cement it contains and for subsequent curing. When the concrete hardens and starts to lose the excess water, shrinkage begins. If the concrete is unrestrained no cracks due to drying shrinkage should develop. But it is virtually impossible to support a structure of any appreciable size without some restraint.

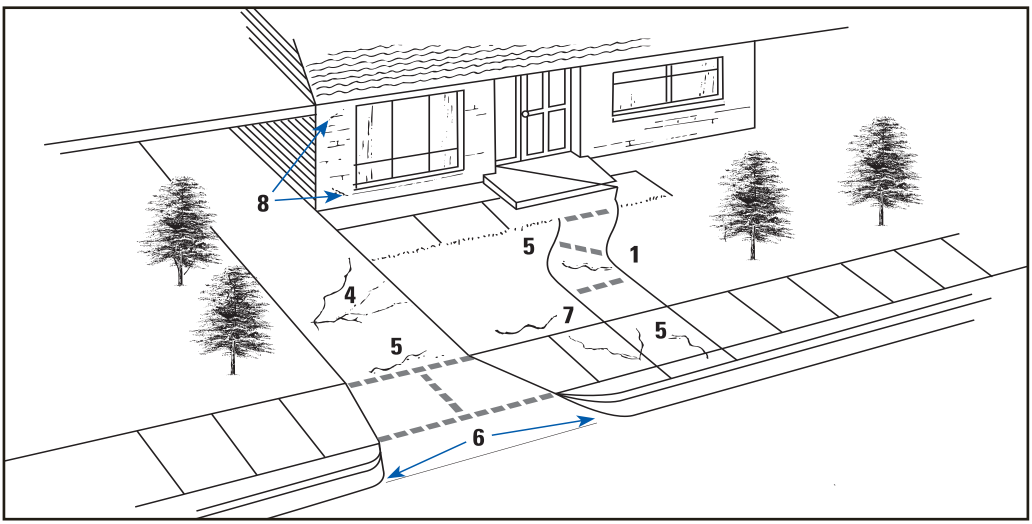
The cracking phenomenon is complex and depends upon a number of things – rate and amount of drying, drying shrinkage, tensile strength, tensile strain, creep, elasticity, degree of restraint and other factors. In the laboratory, drying shrinkage tests are the most easily and most frequently performed tests in relation to shrinkage/cracking problems. However, there is sometimes too much emphasis on the drying shrinkage of hardened concrete as the criterion of susceptibility to cracking.

Types and causes

Cracks and causes, can be divided into three broad categories:

- Cracks occurring before and during hardening.
- Cracks occurring after hardening of concrete.
- Cracking resulting from structural design or accident.





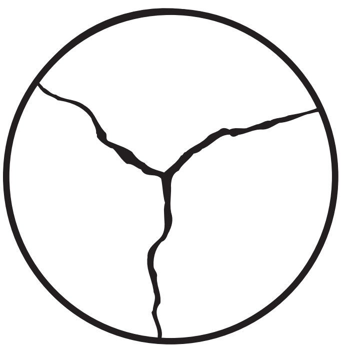
Types of Cracks

1. Shrinkage cracks – avoid by cutting contraction joints along dotted lines.
2. Shrinkage cracks caused by stress concentration at corners – prevent by placing expansion joint along dotted line, or by using reinforcing steel.
3. Settlement crack caused by movement of sub-grade or footings.
4. Cracks due to heaving under slab through poor drainage of sub-grade.
5. Expansion cracks – prevent by placing expansion joints at dotted lines.
6. Shrinkage cracks in feathered sections. Narrow feathered sections should be avoided.
7. Plastic shrinkage cracks, due to quick loss of water to dry sub-grade or to the atmosphere.
8. Shrinkage cracks at door or window corners – avoid by use of reinforcing steel or (in solid concrete walls) by careful placement of low slump concrete.

Cracks before and during hardening

Plastic shrinkage cracks occur when wind velocity, low relative humidity, high air temperature, or a combination of all three, cause water to evaporate from a concrete surface faster than it can be replaced by bleeding to the surface. The rapid evaporation which causes this cracking can be checked by windbreaks, shading and efficient curing.

Cracks after hardening

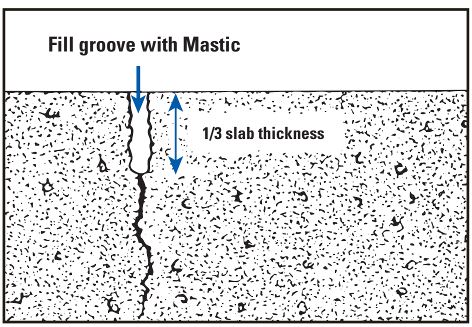


Typical three-branched crack resulting from drying shrinkage.

This category covers the performance of concrete after its form can no longer be altered without damage. It includes the cracks caused by the later stages of drying shrinkage, as well as those which result from the moisture movements which take place in almost all materials undergoing alternate stages of wetting and drying.

Contraction joints cut one third the depth of the slab permit freer contraction and help establish direction of any cracking.

Picture at left: Typical three-branch plastic shrinkage crack, caused by too rapid loss of water soon after concrete has been finished.



Grooves and joints

Shrinkage cracks cannot always be prevented, but they can be controlled by making planes of weakness to establish the direction of cracking when contraction occurs. This is done by cutting grooves one third the thickness of the slabs, and is done as soon as the concrete is hard enough to resist damage by the saw.

In Summary:

The majority of cracks occur within 72 hours after concrete has been placed. These are preventative measures which will minimise cracking in this period.

- See that the sub-grade is well compacted.
- Check that form work is firm.
- Ensure that sub-grade and form work are moist before placing concrete.
- Do not add water to ready-mixed concrete in placing.
- Adequately compact the concrete.
- Cut sufficient contraction joints to allow for shrinkage and/or provide crack inducers to control location of cracking at early ages.
- Provide expansion joints where necessary.
- Start curing as soon as possible.
- Maintain proper curing for an adequate period.

Glossary

Glossary of Terms

Admixture – a material other than water, aggregates and cement, used as an ingredient of concrete to alter its basic characteristic.

Accelerator – a chemical which, when added to concrete shortens the time of set, or increases the rate of hardening or strength development.

Aggregate – granular material such as sand, gravel, stone and slag, which when bound together by portland cement paste forms concrete.

Aggregate, Heavyweight – a heavier than normal aggregate such as barite, magnetite, limonite, ilemenite, iron or steel used to produce extra heavy concrete.

Aggregate, Lightweight – a lighter than normal expanded aggregate made from basic materials such as clay, slate, fly ash, vermiculite, pumice or scoria used to produce lightweight concrete.

Air Entraining Agent – an admixture for concrete which causes air to be incorporated in the form of minute bubbles in the concrete during mixing, usually to increase its workability and frost resistance. Normally expressed as AEA.

Batch Plant – an installation of equipment including bins, batchers and/or mixers as required for batching or for batching and mixing concrete materials; also called mixing plant when equipment is included.

Bonding Agent – a substance applied to an existing surface to create a bond between it and a succeeding layer as between a sub surface and a terrazzo topping.

Broom Finish – the surface texture obtained by stroking a broom over freshly placed concrete.

Bush Hammer Finish – a finish on concrete obtained by chipping off the surface mortar.

Cement Content – quantity of cement contained in a cubic metre of concrete.

Cement, Expansive – a special cement, which when mixed with water, forms a paste that tends to increase in volume at an early age used to compensate for volume decreases due to drying shrinkage.

Cement, High Early Strength – cement characterised by producing earlier strength in concrete than regular cement.

Cement, Hydraulic – a cement that is capable of setting and hardening under water, such as normal portland cement.

Cement, Portland – hydraulic cement obtained by combining and burning limestone and clay to form amounts of gypsum, is then ground to produce a powder.

Central Mixed Concrete – concrete which is completely mixed in a stationary mixer before it is transported to the job. It can be transported in mixer trucks, agitators or dump type trucks.

Chute – a rounded trough or tube for sliding concrete from a higher to a lower point.

Compressive Strength – the measured maximum resistance of a concrete specimen to compressive loading expressed in megapascals (MPa).

Concrete – a composite material which consists mainly of aggregate, portland cement and water, normally weighing 2200-2300kg per cubic metre.

Concrete, Foamed – concrete made very light and cellular by the addition of a prepared foam or by generation of gas within the unhardened mixture.

Concrete, Lightweight – concrete made with lightweight aggregate; the unit weight of the resulting concrete is in the range of 1500 to 1950kg per cubic metre.

Concrete Pump – an apparatus which forces concrete to the placing position through a pipeline or hose.

Concrete, Reinforced – concrete construction which contains mesh or steel bars embedded in it.

Construction Joint – a normally keyed joint formed by a bulkhead between successive placements of concrete.

Contraction Joint (Control Joint) – a joint or deep groove separating concrete in a structure or pavement designed to prevent formation of cracks elsewhere in concrete.

Conveyor – a device for moving materials; usually a continuous belt, system of buckets, a confined screw or pipe through which material is moved by air or water.

Core Test – compression test on a concrete sample cut from hardened concrete by means of a core drill.

Corrosion – disintegration or deterioration of concrete or reinforcement by electrolysis or by chemical attack.

Craze Cracks – fine, random cracks or fissures caused by shrinkage which may appear in a concrete surface within a few days of placement.

Curing – maintenance of moisture and temperature of freshly placed concrete during some definite period following placing, casting or finishing to provide enough moisture and the proper temperature level to promote continued hydration within the hardened concrete.

Drum Speed (RPM) – the various rates of rotation of the drum of the mixer when used for charging, mixing, agitating or discharging. These various drum speeds are usually outlined on the mixer rating plate.

Drying Shrinkage – contraction caused by moisture loss from hardened concrete sometimes resulting in cracks in the concrete occurring days, weeks, or months after placement.

Dusting – a defect in a slab surface; the powdering of the surface under foot or vehicle traffic. Usually caused by overtrowelling wet concrete.

Efflorescence – a deposit of salts, usually white, formed on a surface, the substance having emerged from below carried by water vapour.

Entrained Air – microscopic small air bubbles intentionally incorporated in concrete during mixing to improve durability and workability.

Entrapped Air – large air voids in concrete which are not purposely entrained; generally larger than 1mm and are usually due to incomplete consolidation.

Expansion Joint – a separation in the concrete filled with compressible material to allow room for the expansion of the concrete in hot weather or movement due to other causes.

False Set – premature stiffening of freshly mixed portland cement concrete. Plasticity can usually be regained by further mixing with no additional water.

Flash Set – the rapid development of rigidity in freshly mixed portland cement concrete, usually building up considerable heat. Rigidity cannot be dispelled nor can the plasticity be regained by further mixing without addition of water.

Flexural Strength – the ability of concrete to withstand bending measured by breaking a test beam.

Float – a tool, usually of wood, aluminium or magnesium, used in finishing operations to impart a relative even (but not smooth) texture to a fresh concrete surface immediately after placement and strike off.

Fly ash – the fine ash resulting from the burning of powdered coal in electric utility plants, sometime used as a mineral admixture.

Groover (Jointing Tool) – a tool used to form grooves or weakened lane joints in a concrete slab before hardening to control crack location.

Gross Vehicle Load – the weight of a vehicle plus the weight of a load thereon.

Grout – a mixture of cement and water with perhaps some fine material used to fill cracks and voids in concrete or to prime concrete pumps.

Hardener – a chemical applied to concrete floors to reduce wearing and dusting.

Hairline Cracking (Crazing) – small cracks of random pattern in a concrete surface caused by too rapid surface drying.

High Early Strength Concrete – concrete which, through the use of high-early-strength cement or admixture, is capable of attaining specified strength at an earlier age than normal concrete.

Mineral Admixture (Pozzolan) – a fine powdered material such as flyash which may be used to improve workability or strength characteristics of concrete.

Mixer Capacity – the volume of concrete permitted to be mixed or carried in a particular mixer or agitator.

Mortar – usually consisting of cement, water and sand; no coarse aggregate.

Plastic Shrinkage Cracks – cracks which appear in fresh concrete during or just after finishing. They are often at an angle to side forms but parallel to each other.

Pile – a long slender timber, concrete or steel structural element driven, jetted or otherwise embedded on end in the ground for the purpose of supporting a load or of compacting the soil.

Retarder – an admixture which delays the time of set of concrete.

Rubbed Finish – a finish obtained by using an abrasive to remove surface irregularities from concrete walls or columns.

Schmidt Hammer (Trade Name), Swiss Hammer, or Rebound Hammer – a device used to estimate the compressive strength of hardened concrete by measuring surface hardness.

Screed – a tool for striking off the concrete surface.

Segregation – a) separation of the coarse aggregate from the mortar portion of the concrete; b) improper balance of the aggregate sizes from stockpiles or bins resulting in stony or sandy mixes.

Shrink-Mixed Concrete – concrete which is partially mixed in a plant mixer to intermingle the materials and observe consistency; it is then discharged into a truck mixer where mixing is completed.

Slump – a measure of consistency or wetness of freshly mixed concrete.

Slurry – a wet mixture of water and portland cement; usually containing no aggregate.

Spalling – a chipping or peeling off of concrete surface or corners.

Swirl Finish – a nonskid curving texture imparted to a concrete surface during final finishing.

Topping – a) a layer of high quality concrete placed to form a floor surface on a concrete base, or b) a dry shake application of a special material to produce particular surface characteristics.

Truck-Mixed Concrete – concrete, the mixing of which is accomplished in a truck mixer.

Vibrated Concrete – concrete compacted by vibration during and after placing.

Water Reducing Agent – a material which either increases workability of freshly mixed concrete without increasing water content or maintains slump with a reduced amount of water.

Glossary

Products

Architectural

Products such as Boralstone, Colori and Exposé are among the many specialised architectural products available. The extensive range of products are available to add unique and creative alternatives for flooring, driveways, external areas and pool surrounds. It truly is creativity in concrete, limited only by your imagination.

High Performance

Developed with the assistance of Boral's highly respected Concrete Research and Development laboratory, Boral's high performance concretes have been used in many technically demanding projects around Australia.

Normal Concrete

Boral's range of Normal concrete products is designed for general purpose applications such as slabs on ground, footpaths, foundations and general paving.

Special Purpose

With over 60 years experience in concrete manufacturing, Boral has developed a wide range of Special Purpose Concrete products designed to help you deliver your project on time.

Boral website:

Visit the **Boral website** for the full range of Boral products www.boral.com.au or for specific concrete information visit www.boral.com.au/concreteproducts For your nearest concrete plant log onto www.boral.com.au/concretelocations

Customer Service:

at Boral we are committed to excellence in service so for further information please contact:

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